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ABSTRACT

Data from the National Assessment of Educational Progress and accompanying machine-readable documentation are currently maintained on the National Military Command Information Processing System (NIPS) data base management system. National Assessment's data management and file processing systems, however, are not well-suited to secondary users. Because substantial resources and external assistance would be required to document the National Assessment data files more clearly and make them easy to use, the Education Commission of the States (ECS) participated in a National Science Foundation grant to study the utility of secondary analysis with National Assessment data. The design phase, compromise and rejected alternatives, implementation, contents of the public use data tapes, and utilization are described. Currently, National Assessment staff are involved in three tape-related activities: enhancing the existing tapes, creating new tapes, and developing an introduction to the public-use data tapes. (Author/GK)

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NATIONAL ASSESSMENT'S PUBLIC-USE DATA TAPES

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SECONDARY ANALYSIS OF NATIONAL ASSESSMENT DATA

Chair: Herbert J. Walberg
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INTRODUCTION

When the U.S. Office of Education was chartered in 1867, one charge to its commissioners was to determine the nation's progress in education. The National Assessment of Educational Progress (NAEP) was initiated a century later to address, in a systematic way, that charge. National Assessment is administered by the Education Commission of the States (ECS), an interstate compact of forty-eight states, American Samoa, Puerto Rico and the Virgin Islands. The assessment is funded through 1983 by a grant from the National Institute of Education.

National Assessment is a continuing survey of the knowledge, skills, understandings and attitudes of young Americans. Each year for the past 11 years, 75,000 to 100,000 persons have been assessed in one or more learning areas taught in the schools. During that period, National Assessment has conducted major assessments in art, career and occupational development, citizenship, literature, mathematics, music, reading, science, social studies, writing and in several other learning areas on a smaller scale. Nine of these major areas have been reassessed one or more times. The age groups assessed are 9-year-olds, 13-year-olds, 17-year-olds and occasionally young adults, aged 26-35.

Learning-area assessments evolve from a consensus process. Each assessment is the product of several years of work by a great many educators, scholars and lay persons from all over the nation. Initially, these people design objectives for each learning area, proposing general goals they feel Americans should be achieving in the course of their education. After careful reviews, these objectives are given to exercise (item) writers, whose task it is to create measurement tools appropriate to the objectives.

When the exercises have passed extensive reviews by subject-matter specialists, measurement experts and lay persons, they are administered to deeply-stratified, multi-stage probability samples. To minimize school disruptions and respondent burden, exercises are divided into a number of forty-five minute booklets; each booklet is adminstered to a separate, randomly equivalent probability sample of about 2,500 respondents. Sample selection and data collection are done by the Research Triangle Institute, Research Triangle Park, North Carolina. Printing and scoring of assessment materials are done by Westinghouse DataScore Systems (formerly Measurement Research Center), Iowa City, Iowa.

After assessment data have been collected, scored and analyzed, National Assessment publishes reports to disseminate the results as widely as possible. Not all exercises are released for publication. Because National Assessment will readminister some of tne same exercises in the future to determine whether the performance level of Americans has increased, decreased or remained the same, it is essential that they not be released in order to preserve the integrity of the study.

PUBLIC-USE DATA TAPES

National Assessment data and machine-readable documentation are currently maintained on the NIPS (National Military Command Information Processing System) data base management system. This is a public domain system developed by the IBM Federal Systems Division for the Department of Defense and other federal agencies. Both data and documentation are stored in complex, hierarchically structured files. A retrieval subsystem extracts specifications and documentation and uses them to create generalized format workfiles and parameter files for analysis programs. This approach permits efficient storage and management of both data and documentation as well as flexible, powerful data analysis and report generation systems for National Assessment.

Unfortunately, National Assessment's data management and file processing systems are not well-suited to secondary users. Exercise documentation files are organized by exercise rather than by ages or booklets. Labels and linkages were designed to compactly fit internal National Assessment processing needs and to facilitate tracking individual exercises across age levels and assessment years. The level and style of documentation for other variables (e.g., demographic and background variables) is largely a function of the purpose for which they are used. It ranges from archival paper documentation to hierarchical data files containing analysis and report specifications.

Data files are hierarchically organized at the school and respondent levels. They contain non-numeric codes to represent special conditions and save space (highly efficient in a PL1 environment, but not compatible with most FORTRAN-based statistical packages). Labelling conventions are designed to fit the internal processing system. By early 1979, over 300 different data files had been documented and disseminated to secondary researchers. Each researcher had to learn unfamiliar documentation formats and terminology and also had to prepare labels, formats, missing data codes, etc. before doing any analysis. Most researchers also had to edit out the nonnumeric codes which occurred in nearly all data fields.

It was clear that substantial resources and external assistance would be required to document the National Assessment data files more clearly and make them reasonably easy to use. Thus, ECS was pleased to participate in the National Science Foundation grant to study the utility of secondary analysis with National Assessment data(1). ECS agreed to furnish public-use data files and documentation for three recent assessments. The assessment years, subject areas, ages and number of booklets (data files) included in the study are shown in Exhibit 1. A special trend analysis tape from the 1972-73 mathematics assessment (prepared simultaneously with NIE funds) is also shown. Except for the 1977 adult survey, each booklet was given to a separate national sample.

Exhibit 1. Number of Booklets Included in National Assessment Public-Use Data Tapes By Year, Subject Area and Age Level

Year	Subject Area	Ages 9	13	17	26-35
1977-78	Mathematics	7	11	12	
1976-77	Science	7	10	11	
	Energy, Health, Reading and Science				4
1975-76	Citizenship/Social Studies	5	8	9	
	Selected Supplemental Mathematics		2	2	
1972-73	Mathematics (for trend comparisons with 1977-78)	7	9	11	

Design Phase

During the design phase, ECS staff reviewed user problems with previous files and consulted numerous data archivists, documentarians, and analysts, including the grant participants. Alice Robbin at the University of Wisconsin provided helpful advice and leads on numerous occasions. ECS staff visited the Inter-University Consortium for Political and Social Research (ICPSR) to learn about their archiving standards and procedures. Other persons consulted included Richard Roistacher at the Bureau of Social Science Research, Barbara Aldrich at the Census Bureau and Thomas Brown at the National Archives. Major statistical software system (e.g., SPSS, SAS, OSIRIS) documentation was also studied in an effort to maximize compatibility with them.

Major design criteria for the public-use data tapes included ease of use, portability and complete respondent information. Insofar as possible, tapes would be self-documenting. That is, they would contain machine-readable documentation files and require minimum supplemental documentation or support from National Assessment staff.

The ICPSR documentation and standards proposed by Roistacher (1979), Aldrich (1978) and Aldrich and Glimpse (1979) were adopted, with minor modifications, for the National Assessment public-use data tapes. Implementation decisions are outlined below.

- The basic data unit is a respondent's exercise booklet and all associated data within an assessment year and age level. Thus, if a booklet contains items for multiple learning areas, data for the entire booklet are contained in a single file, when possible. Because most respondents take only one booklet, this unit allows a rectangular file with variables on one dimension and respondents on the other. Higher level data (e.g., school-level) is repeated on each respondent record to avoid hierarchical file structures.

  Some respondents, such as out-of-school 17-year-olds and young adults may take up to four different exercise booklets. Combining files across booklets for these respondents would create several problems, including files too large for many analysis packages to process efficiently. Consequently, separate files are created for each respondent (of this type) and sufficient linkage is provided to allow the files to be combined.

- The basic documentation and dissemination unit is an age level within an assessment year. If, within an age level, booklets are modular by learning area (e.g., two mathematics booklets and seven citizenship/social studies booklets), then the documentation unit is the learning area within age level and assessment year. Within these units, most documentation is common to all booklets; using booklets as basic units would be needlessly redundant. In many respects, the assessment year is a logical unit, but would require users with age-specific interests to purchase large, expensive, multi-reel files.

- Data files contain all original data fields except confidential subregional identifiers and certain redundant or irrelevant housekeeping variables.

- For the first time, copies of all exercises -- both public and secure -- are provided to researchers who agree not to publish the secure exercises. Exercise text is not included in machine-readable form for cost reasons, but it is included on 24X (ERIC-compatible) microfiche.

- Documentation uses only the most commonly used subset of the ASCII and EBCDIC character sets.

- Documentation has been rewritten to follow the recommendations of Roistacher, et. al., and to minimize internal jargon.

- Names and labels for most variables were redefined to be clearer to external users and to provide common labels for background/demographic variables that extend across ages or assessments.

- Exercise cross reference listings are presented in booklet-exercise order within booklet, the most usable sequence for external users.

- Insofar as possible, data and documentation files are compatible with major statistical packages, including SPSS, OSIRIS and SAS. To achieve compatibility, data files are rectangular and all-numeric, with uniform high order codes for "I don't know", no response and missing data. Labels also meet size requirements of the commonly used packages.

- Program-readable documentation files are included for both SPSS and OSIRIS. SPSS was chosen as the closest approximation to a universal analysis package; most users would have to create data definition files prior to doing any analyses. Further, interfaces are available for most other statistical packages. OSIRIS files are included because it appears to have the best codebook documentation component of any major analysis package and is used by the Inter-University Consortium for Political and Social Research (ICPSR), through which National Assessment may disseminate its files.

Compromises and Rejected Alternatives

As noted above, text and labels for exercise variables were not included in machine-readable form. There are so many exercises and so many of them include graphics that it was not feasible to provide text and labels.

There was considerable discussion in the planning stages about combining all files for (at least) an age level in an assessment year. Such a file would have all variables common to all booklets first, followed by booklet-specific variables. While initially appealing, it soon became clear that the file would be too large for most statistical packages and would be unreasonably expensive for most users to read and process. Instead, the data for each booklet were put in separate files but names were kept constant for common variables.

On the near-unanimous advice of consultants and users, most transformed variables are not included. A few standard National Assessment reporting variables that are defined for most files with common names, labels and documentation are included. Consultants felt strongly that priority should be given to producing well-documented versions of original data. While transformed variables are required to replicate National Assessment results, they would enormously expand both the size and complexity of the files -- and represent an undesirable complication for secondary users.

Implementation

At the end of the initial planning stage, an NIE-funded data access conference was convened to consider broad questions of access to National Assessment records and data as well as to review the public-use data tape plans. The attendees, including data archivists, analysts and grant participants, were supportive of the tape plans and suggested a number of improvements. At about this stage (early November 1979) it became apparent that the proposed system would far exceed both the budget and timelines for delivery of products to the grant participants. Rather than degrade the product, the participants agreed to accept copies of existing files and internal documentation to be followed as soon as possible by the planned files. Actual costs for the total effort were in the range of eight to twelve times the level of NSF funding, while it took three to nine months longer to do the work than initially estimated. ECS knew that the amount budgeted was low, but expected it to be low by a factor of two or three. Some of the contributing factors are explored below.

First, National Assessment's machine-readable documentation has evolved over a period of about ten years; it is a complex, highly interrelated system. Several early design decisions, such as changing variable names to make them clearer and transforming "I don't know", no response and missing value codes to uniform values had unanticipated ripple effects. More accurately, most of the effects were anticipated, but not their magnitude. For example, scoring guides for free-response exercises had to be entirely redone to reflect coding changes -- and it was almost but not quite feasible to do the task mechanically. The name changes were less mechanical than estimated, as internal names were more deeply embedded in other documentation than expected, and the two sets of labels are not isomorphic -- mechanical substitution is not possible.

National Assessment's documentation and processing systems and files already exceeded the design limits of the data base management system. Background and exercise variables are documented in different systems, while exercise documentation files reflect many assessment year and/or learning area idiosyncracies. Rather than create a separate, largely redundant documentation file for the public-use data tapes, additional documentation was added to existing files -- with much attendant patching and complex "fixes." While painful and expensive, the transition to a more powerful data base management system in 1981 will be more feasible with this approach.

Inevitably, many of the non-exercise (background and demographic) variables were not adequately documented for the public-use data tapes. It took much longer than planned to retrieve paper documentation from archives, verify questions with contractors and get the documentation into machine-readable form.

In late 1979 and early 1980, National Assessment converted from a batch processing computer to one with interactive processing. The new system has permitted production of a better product -- errors and awkwardness could be corrected in hours rather than days or weeks -- but the time lost in correcting hardware bugs and learning a new system hurt at the time.

Finally, the task undertaken was simply too much -- 88 data files in 12 year/age/learning area combinations (plus 27 files required by NIE). It was necessary to do as much as possible by computer. Massive reprogramming and clerical work may be required to make even minor improvements in the tapes.

Contents of the Public-Use Data Tapes

In general, a separate public-use data tape is provided for each age level in an assessment year. A public-use data tape contains:

- Print-image files containing a User's Guide, including technical appendixes. The User's Guide documents assessment procedures and provides information about the data files.
- A print-image codebook for each exercise booklet. There is a codebook entry for each variable containing variable number, labels, tape positions, frequencies and labels for each value, missing data codes, data origin and references to appendixes (if relevant).
- SPSS card-image files, with all data definition and control cards needed to create labelled systems files and begin data analysis.
- OSIRIS-IV internal format card-image files containing codebook information for each exercise booklet.
- A separate, rectangular, respondent-level data file for each exercise booklet. There are typically about 2,200 to 3,200 respondents per booklet.

Each tape is accompanied by a printed copy of the User's Guide, a tape list and a dump of the first 50 records of each data or documentation file. Attachments include:

- Copies of exercise booklets, exercise scoring guides and other data collection forms on 24X microfiche
- Objectives booklet(s) for the assessment learning area(s)
- A National Assessment publications list

One of the grant objectives is to recommend archiving and dissemination mechanisms for the National Assessment public-use data tapes and other major educational data bases. In the interim, National Assessment files may be obtained from National Assessment (2). By mid-1981, they will be available from the National Archives and Record Service and may also be disseminated by ICPSR to member institutions.

Utilization

The first tapes, for the 1977-78 mathematics assessment, were produced in March 1980. All tapes, including a revised version of the 1977-78 mathematics tapes were produced between August and November of 1980. In November, Northern Illinois University hosted a workshop on secondary analysis of National Assessment data. Teams from seven universities attended sessions on National Assessment, the public-use data tapes and analysis strategies employed by the grant participants at Northern Illinois University, the University of Minnesota and the University of Illinois - Chicago Circle. By the end of the workshop, all of the teams had created systems files and done preliminary analyses. The participants subsequently ordered a total of 41 tapes for further analyses at their own campuses. In May the group will reconvene at Northern Illinois to critique the analyses and share their experiences in using the tapes.

In late 1980, ECS and NIE awarded nine contracts for secondary analysis of the mathematics public-use data tapes and/or research on assessment methodology. Eight of those contracts include analysis of mathematics or citizenship/social studies data. The tape users have agreed to help identify the strengths and weaknesses in documentation, format, etc. and to evaluate the overall utility of the data sets for their research interests.

By March 1981, over 100 tapes had been disseminated to 19 different sites. The sites and type of involvement are shown in Exhibit 2. Clearly, most of the usage has been generated by the NSF grant and workshop and by the ECS/NIE contracts. To date, National Assessment has not formally publicized the availability of the tapes and anticipates considerable broader interest in the future.

New Developments

National Assessment staff are currently involved in three major tape-related activities: enhancing most of the existing tapes, creating new tapes and developing an introduction to the public-use data tapes. Enhanced versions of existing mathematics

Exhibit 2. Sites with National Assessment Public-Use Data Tapes, March 1981

Institution	Type of Involvement
American Institutes for Research	ECS/NIE contract
U. of California, Berkeley	NSF-funded workshop
U. of Chicago	other
U. of Colorado, Boulder	NSF-funded workshop
U. of Florida	NSF-funded workshop
U of Georgia	NSF-funded workshop
Iowa State	other
International Ed. Services	ECS/NIE contract
U. of Illinois, Urbana/Champaign	ECS/NIE contract, other
U. of Illinois, Chicago Circle	NSF grant
U. of Massachusetts	ECS/NIE contract
U. of Minnesota	NSF grant, ECS/NIE contract
National Institute of Education	funding agency
U. of North Carolina, Chapel Hill	other
Northern Illinois U.	NSF grant, ECS/NIE contract
Ohio State	NSF-funded workshop
Research Triangle Institute	ECS/NIE contract
Stanford	ECS/NIE contract
SUNY Stoney Brook	NSF-funded workshop
U. of Uppsala, Sweden	other

and citizenship/social studies tapes will be available after May 1981. Major enhancements include:

- o SAS-readable documentation files, with all control cards needed to create labelled systems files and begin analysis.
- o Program-readable item documentation files, with codebook and appendix information, less carriage controls, headings, etc.
- o A balanced half-sample replicate definition file, for use in variance estimation.
- o Revised documentation, particularly on sampling weights and variance estimation procedures(3).

New public-use data tapes are being created for the 1970-71, 1974-75 and 1979-80 reading assessments. Tapes for the 1979-80 assessments are scheduled for release in October; the remainder are scheduled for November. Reading is the first assessment for which data will be available for three full-scale assessments. National Assessment currently plans to release tapes in 1982 for the 1969-70, 1973-74 and 1978-79 writing assessments. The writing tapes should include both the normal background and exercise variable data and the keypunched essay subsamples that were used in scoring for mechanical correctness.

Finally, National Assessment staff are working on an introduction to the public-use data tapes, scheduled for initial release in late fall. It is intended for researchers with primary competence in a subject area or methodology and some familiarity with statistical software packages. The puposes of the introduction are to:

- o Help potential users decide which, if any, National Assessment tapes suit their purposes.
- o Help actual users decide which files and documentation to use in getting started.
- o Provide examples of the steps required to create SPSS or SAS system files and begin analysis.
- o Alert users to common problems, answer frequently asked questions, etc.
- o Point to interesting secondary analyses of National Assessment data, particularly those that document the steps taken to get to substantive analyses.

National Assessment will also offer an optional tape which contains relevant portions of a regular public-use data tape as well as the data and all control cards used to create examples in the introduction.

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NOTES

(1) NSF Grant No. SED79-17259 to the University of Illinois at Chicago Circle, with subcontracts to the University of Minnesota, Northern Illinois University and the Education Commission of the States. The ECS portion of this project was partially funded by the National Institute of Education.

(2) For further information, contact David J. Wright, National Assessment of Educational Progress, 700 Lincoln Tower, 1860 Lincoln St., Denver, Colorado 80295. (303) 830-3752

(3) Numerous users have provided helpful advice and criticism, but special recognition is due to Nancy Burton at the University of North Carolina, Chapel Hill for her diligence in documenting awkward or ambiguous language, problems and errors, as well as for her many suggested improvements. Rose Edith Sitgreaves Bowker at NIE has also provided invaluable advice and assistance on alternative approaches to variance estimation.